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TOPOGRAPHIC NOTES ON THE URAL MOUNTAINS.

BY

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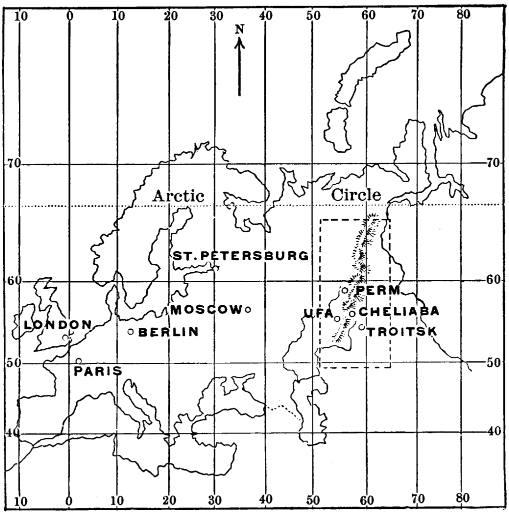
The study of mountain-regions has resulted in a classification, with regard to orographic features, of the various parts of the continents known to geographical research. This classification is justly, as it seems to the writer, based on age. Its many submodifications are all dependent, primarily, on the difference in length of time during which the given mountain system has been subjected to the forces of erosion and those producing elevation and depression.

The difference of climatic conditions, little or much rainfall, even or uneven and rapidly-changing temperature, may be noted in their effects by the experienced observer, who sees for the first time a given mountain-tract. He will find himself deceived, however, if he does not take into account time, the determining factor of all topographic features of large character.

Considered from a purely topographic standpoint, it may be said that the geological structure itself is subordinate in determining the resulting forms to the all-powerful control of time. Witness in this regard the gigantic masses of Mt. Fairweather and Mt. St Elias on the Alaskan coast, long taken for volcanic mountains by geographers as well as by navigators, and only by close observation and comparison determined to be of sedimentary structure. Or, the writer may cite the dome-shaped mountains seen by him during the past summer along the upper reaches of the Yenisei river, which superficially resemble bosses of plutonic rock, but which on close inspection are seen to be composed of nearly horizontal beds of Carboniferous sandstone.

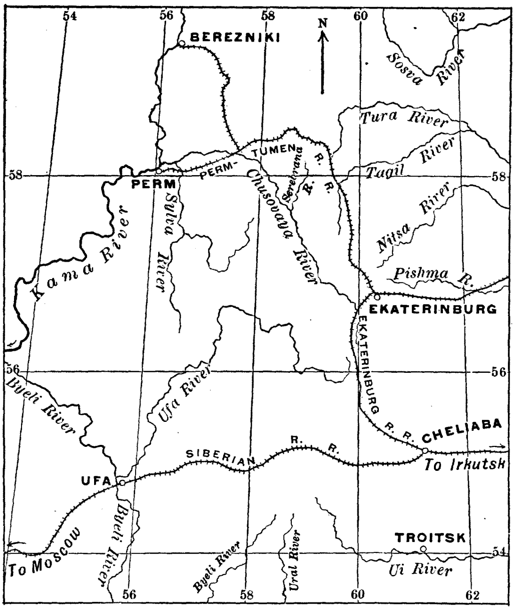
Perhaps there is no more striking example, in those portions of the earth's surface already known to investigators, of what may be called deceptive mountain togography than is presented by a study of the Ural mountains in eastern Russia. This field has been long studied from many geological and mineralogical standpoints, and from it have been drawn, in fact, in the fields of palæontology and mineralogy important contributions to the classic nomenclature of those sciences. It is possible that contributions have also been made from this field to the literature of modern geographical study; but the writer, although not familiar with all the work which has been done by the Russian geologists in that portion of the country, feels a reasonable degree of confidence that the Ural has not been considered to any extent from the point of view taken in the present article. Over so large an area notes such as the following must necessarily be of a rather general character. As the observations recorded are, however, the result of a considerable amount of time spent in the field, it is hoped they may be found of value for the purposes of comparison with descriptions of regions better known to Americans.



SKETCH MAP OF EUROPE, SHOWING LOCATION OF AREA DESCRIBED.
SCALE APPROXIMATELY 700 MILES TO 1 INCH.

From the northern border of the Caspian Sea northward even to the Arctic Ocean extends the broad and poorly-defined series of low mountains and hills known as the Ural chain. Geologically considered, the area in question is a mountain region of the purest type. Metamorphic schists of both igneous and sedimentary origin, with accompanying dikes and laccolites of igneous rock, with every range in composition from the most acid to the most basic, and in structure from sharply-defined porphyritic to purely granular, present a complexity of folding whose problems it is well-nigh impossible to solve. In almost any section followed across the general north and south strike of the rocks will be found numerous exposures of the schists, exhibiting most intricate folding and minute faulting. In the region between Kushva and Perm, for example, along the Chusovaya river and its tributaries, the extraordinary crinkling of graphitic schists is beautifully set off by the multitude of narrow veins of white quartz interleaved with the laminæ of the schist. In the gold mines of Kochkar, where the underground workings afford opportunity of studying the schistose diorites in a comparatively fresh state, the sections of country-rock exposed in the cross-cuts exhibit all the complicated anticlinal and synclinal structure characteristic of mountain complexes which have been subject to severe disturbances. The saprolitic character of the surface rock interferes with the study of the orographic features in many parts of the country. Indeed it has been found in the mining districts about Troitsk that shafts have penetrated the red, decomposed clayey schists for more than 100 feet before encountering rock sufficiently hard to require a blast. In this particular the Ural region bears a striking resemblance to the southern Appalachians of the United States, and it is the more remarkable inasmuch as the climatic conditions obtaining in the two regions are so entirely different.

The observer is struck as he rides or drives about the Ural with the planed-down appearance of the hills and the entire absence of sharp or accentuated forms. The vast plains, denominated the Steppe, extending from the line of the Trans-Siberian Railroad southward to the Caspian, are, as the strict geographer would use the term, mountains, but so old as to have lost entirely the character of such. An absolute plain is not, so far as the writer knows, to be found in the region, but the Orenburg Steppe must be classed as a peneplain. It will be shown that in all probability this peneplain is not limited in extent, but is part of one great general plain hundreds of miles in length, and in places more than one hundred in width. In the vicinity of Miassky Zavod, on the line of the railway, where the washings for gold-bearing gravels have laid bare large areas of the bed-rock, the intricately folded schists are graphically mapped out on the nearly horizontal floors of the placers. The mountain-complex has been pared down as by some giant knife, and all above the last cut has disappeared. The only indestructible elements, the gold and quartz, have remained, forming a horizontal bed on the top of the edges of the schists. Judging by the comparative richness of the gold placers, and the poverty in this metal of the quartz veins now found in the schists, the mass of material from which this gold came must have been enormous. It is safe, therefore, to infer that very high mountains have existed here, and that much time has been consumed in the process of denudation to the present level. Evidence of a similar nature is afforded by the deposits of platinum, several hundred miles farther north, along the Iss and Tura rivers.



SKETCH MAP OF PART OF URAL REGION, SHOWING LOCALITIES MENTIONED. SCALE 60 MILES TO 1 INCH.

Although the level of the peneplain approaches in some places the present level of the streams, signs of an uplift after a nearly completed cycle of erosion are everywhere visible. Along the railroad, as, for example, near Cheliabinsk, the amount of re-cutting done by the present streams does not exceed ten or fifteen feet vertically. Toward the south, however, the uplift has been greater, and at the rare intervals where streams occur most striking examples of cañon-like topography are seen. The Sanarka and Ui rivers, one hundred and fifty miles to the south of Miassky Zavod, are examples of a drainage superimposed on a country in which well-defined river-courses were already carved. Measurements with barometer taken along the Ui river showed that the top of the peneplain varies in height from 50 to 200 feet above the present river-bed, the variations being due to the fact of the undulating surface of the Steppe. The main river valley is so sharply cut that, although from one cliff to that on the opposite bank the distance is really 1,000 feet, an observer standing on the surface of the peneplain at an equal distance back from the bank nearer to him would not know that there was a cut in the plain.

The undulations referred to in the preceding paragraph cannot be compared with any feature of topography found within the limits of the United States, so far as known to the writer. The rolling prairie country of the upper Mississippi valley can hardly be likened to it, since the waves, if they may be so termed, of the prairies are regularly spaced and not of great individual magnitude. The Troitsk and Orenburg Steppe, on the other hand, may be likened, if it is permissible to use the simile of the ocean, to the sea's surface at a time when a calm has succeeded to violent winds blowing at cross-directions. Billows of land of immense proportions are interspersed with smaller ones, and it cannot be said that there is any regularity either in the size of the rolls, in their distribution, or in their distance from one another. The distance from the crest of one wave of the Steppe to that of the following is from two to four miles. Of such a quality is the atmosphere, however, that it is difficult to believe from mere observation that the distances are so great. One soon becomes convinced in travelling over the ground. The absence of any but the most scant growths of trees in the Steppe regions renders the study of the topographic forms exceedingly easy. In many places the sight is entirely unhindered for distances of fifteen and twenty miles over the immense plains.

The nearly vertical beds of schist and slate cut off sharply at the river-bank form miniature points and promontories similar to those which the writer has seen on a larger scale along the shores of Kadiak Island, in Alaska. Between these cliffs narrow cañons penetrate the plateau for distances of a few hundred feet, occasionally much longer. These cañons of the tributaries have been partially filled with black peat or turf, which, on being closely examined, appears to be little more than compressed, decayed and finely matted vegetable material of a spongy consistency. It is dug out, cut into blocks, and dried for burning by the Kirghiz nomads who inhabit the region. They also use it for banking up the sides and roofs of their winter huts, for the sake of warmth. The turf has frequently a vertical thickness of fifty feet, and it is not easy to account for its origin in this nearly arid region, where there is so little decay of vegetable material. The occurrence would seem to imply that the orographic changes of the region have been accomplished with exceeding slowness to allow of a thick accumulation of decayed vegetable material from comparatively poor sources. For on the Steppe the extraordinary semi-tropical vegetation characteristic of the Siberian forests, and to some extent of the northern Ural, is entirely lacking, and is replaced merely by scant patches of low bushes and patches of growth similar to the American sagebrush.

On the top of the plateau a very thin layer of turf, never exceeding three feet in thickness, is distributed with considerable uniformity. Numerous reefs of quartz and occasionally a band of schist of more than usual hardness form parallel ridges, generally bare of any covering, which may be traced by the eye for long distances across the country. Pits dug through the thin blanket of turf which covers the evenly undulating surface of the Steppe have discovered a bed varying from one to two feet in thickness of fine gravel, well water-worn. This bed lies frequently at a height of 150 feet above the present streams. It rests directly on the upturned edges of the schist, which is found to be of a saprolitic character. The gravel contains rolled particles of gold. It is to be regretted that up to the present this gravel has not been found payably auriferous, otherwise the courses of the ancient channels which the gravel occupies would have been traced. It is, however, a forceful commentary on the nature and origin of the gravel to state that it has been found so high above and so far away from the present water-courses that, although its character of stream-detritus is not to be doubted, it is impossible to extract its values at a profit because of lack of water.

The region of the Ural presents conditions of topographic uniformity at points remotely situated from one another. Thus the high-lying auriferous gravel has been found by the writer, under conditions almost exactly similar to those described above, 250 miles north of the Ui, in the vicinity of the rivers Reft and Pishma. The Pishma region, 100 miles to the north-east of the city of Ekaterinburg, is not Steppe, but is covered with a growth of pine-forest, which, as in all the northern country, serves to conceal in part the topographic details. It is, however, certain that the peneplain which has been described extends over the whole of the Ural, at any rate as far north as the town of Bogoslovsk, latitude 60° N., and it is extremely probable that the water-worn gravel would be found at many points over its surface occupying a position averaging 150 feet above the level of the present drainage.

The Ural chain, in the region lying to the north and south of Kushva, a station on the Perm-Ekaterinburg branch of the Siberian railway, is remarkable for the presence of numerous metalliferous ore-bodies, principally iron oxides of greater or less purity. These ore-bodies are frequently of considerable size, occurring in the form of bosses in the surrounding granular rocks. By their greater ability to resist erosion as compared with the country-rock, they have become, topographically considered, monadnocks in a surrounding sea, so to speak, of peneplain. The most conspicuous examples of these monadnocks are the hills of Blagodatny, near Kushva, and Bogoslovsk, 150 miles to the north. These rise to the height of only a few hundred feet above the peneplain. To the west and north of Bogoslovsk, however, in the almost unexplored wilderness of forest occupying the Ural crest at this latitude, may be seen typical dome-shaped monadnocks rising to 3,000 and 4,000 feet above the plain.

A most striking and comprehensive view of the present topographic conditions is obtained if one mounts to the top of one of the smaller monadnocks in the vicinity of the river Reft, in the forest-covered region between Ekaterinburg and Irbit. Here the peneplain, occupying a position from 150 to 200 feet above the present river-course, is almost level, and covered with an equal growth of pines and firs. The resemblance of the scene to that obtained at some point in the Southern Appalachians of the United States, where similar conditions exist, as, for example, in Northern Georgia, is truly startling. The counterfeiting is aided by the red color assumed by the decomposed saprolitic schists where they are exposed. Indeed, it seems to the writer that no two regions could be, both topographically and geologically considered, more nearly exact counterparts, the one of the other.

Toward the west, in the direction of the Volga, the peneplain lessens very gradually in elevation until it merges into the great plain of northern Europe, which stretches away indefinitely to the west and south. In the course of the railway journey from Kushva down to Perm the results of the former base-levelling are graphically displayed along the course of the Chusovaya river, a large tributary of the Volga, coming from the Ural. The present stream, subject to heavy overflows in the spring, has in its meanderings cut deep and sharp into the sides of the peneplain, which, occupying an elevation of less than fifty feet above the water, is difficult to distinguish from the immense recent flood-plain, composed of gravel, through which the river now makes its way.

It is a remarkable fact, patent to all observers in the district, and worthy of more study than has been given to it by the present writer, that the present streams of the Ural appear for the most part to be filling rather than cutting their channels. In other words, although the streams have cut, as has been said, to depths of 150 feet and more below the surface of the peneplain, they from some cause appear to have nearly suspended this action and wander about with very light grades in the midst of immense plains of gravel. These plains are typical flood-plains, and are generally of a width about ten times that of the streams which penetrate them. A typical river, or rather creek, of this kind is the Serebrana, a tributary of the Chusovaya, heading to the south of the railroad west of Kushva, and flowing south for a distance of 150 miles. It has the peculiarity of all the streams of the Ural, and, in fact, of Siberia in general—that of retaining the same width for very long distances. The Serebrana will average 150 feet in width, and flows in a gravelly flood-plain of its own making, of a width of 1,000 feet or more. From the sides of this plain rise abruptly on both sides the rather steep walls of the peneplain, to a height of 200 feet at least.

In the perfectly flat gravel-plain the stream winds from one side to the other, making typical ox-bow curves and exhibiting all the characteristics of a miniature Mississippi. Crescent-shaped lagoons and bogs which have previously formed part of the river-bed are of constant occurrence. The flood-plain is covered uniformly, except in places occupied by the river channel, with a black soil to a depth of five feet, and except where the peasants have cleared the ground for agriculture, a growth of fir and birch forest has sprung up. As many acres have been laid bare of trees, large tracts of the surface of the flood-plain are open to observation. It is interesting to note the succession of ridges—now, of course, grass-covered—in the form of large curves, hundreds of feet in length, nearly parallel to each other and to the present course of the stream. These ridges are successive banks of gravel thrown up on the inner side of the curve as the river at this point made larger and larger sweeps, cutting at each swing more deeply into its outer bank, extracting material to deposit further down its course. The greater part of this cutting and filling is undoubtedly done in the spring months, when the volume of this river, and of all those of which the Serebrana is a type, is greatly increased. Occasionally, in fact, the whole flood-plain is under water during the time of the breaking up of the ice and the melting of the snow. The covering of the gravel-plain with silt, forming a soil, and the consequent forest growth, is thus explained. Although the velocity of the stream averages two feet per second in the dry season, and must in the spring be considerably accelerated, yet it is likely that the actual eroding action of the stream at present is very small. Its energy is expended in transporting and retransporting hither and thither the gravel and silt encumbering its valley. The percentage of this material actually carried out of its own valley into that of the Chusovaya must be an almost negligible quantity.

Not the least remarkable feature of the Serebrana valley is its shallow character. It has been well determined by pit-sinking in various parts of the flood-plain that from the surface of the soil down to the underlying rock the vertical section is but fifteen feet, and that the depth is remarkably uniform in all parts. Considering the fact that the valley occasionally reaches 2,000 feet in width, this lack of depth is extremely significant. It certainly points to the conclusion that much time has elapsed since the initiation of the present drainage. The small size, well water-worn and extremely uniform character of the pebbles, of which a large proportion are quartz, are evidence in the same line.

The description of the Serebrana river valley has been given with an amount of detail perhaps unwarranted by the tenor of the present article. The writer wishes to emphasize the fact, however, that the conditions here found are paralleled by hundreds of examples which might be cited, both in the Ural, along its entire length, and, with a difference only of scale, in Central and Eastern Siberia. Taking the Ural alone, however, it affords an example of remarkable uniformity of conditions extending over great areas. It is difficult to realize to-day, as one looks at the gently rolling steppe and the hills of insignificant height which compose the Ural, that here must have existed peaks as high at least as the Alps and the Sierra Nevada. Evidence afforded by the detritus of these mountains and by the various topographic conditions which have been referred to leaves scarcely room for doubt that the existing Urals are but the bases of mountains which were several times the height. From the facts set forth in this article, it appears to the writer a tenable opinion that the Ural is one of the oldest ranges, if not the oldest mountain range, to be found in those portions of the earth's surface known to scientific investigation.